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(54) A laser marking system

(57) A method and apparatus for marking articles wherein an article is marked by means of a laser beam which is deflected and controlled such as to apply a plurality of laser burn dots in a predetermined pattern on the article. The laser (10) can be modulated continuous wave or pulsed and in both cases is arranged to direct a beam of pulses onto a deflection device (12) which deflects the pulses in space via an optical system (14, 18), onto an article (16) to be marked. The deflecting device (12) can be an acousto-optic deflector or a mirror arrangement controlled electronically in dependence upon the character to be applied to the article. When the deflecting device deflects the beam, in one dimension only, then the article is necessarily displaced during the marking process in a direction perpendicular to the deflection plane of the beam. When the deflecting device can deflect the beam in two dimensions (X, Y), then the article can be stationary during marking.

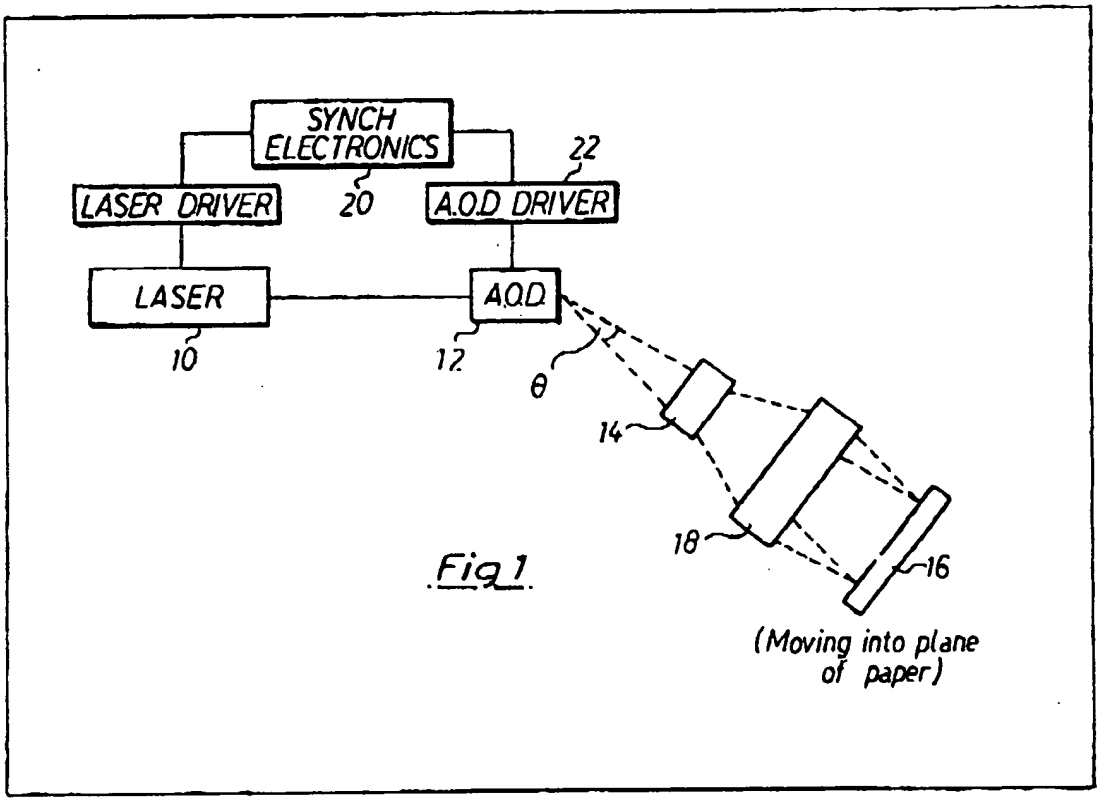

Fig 1.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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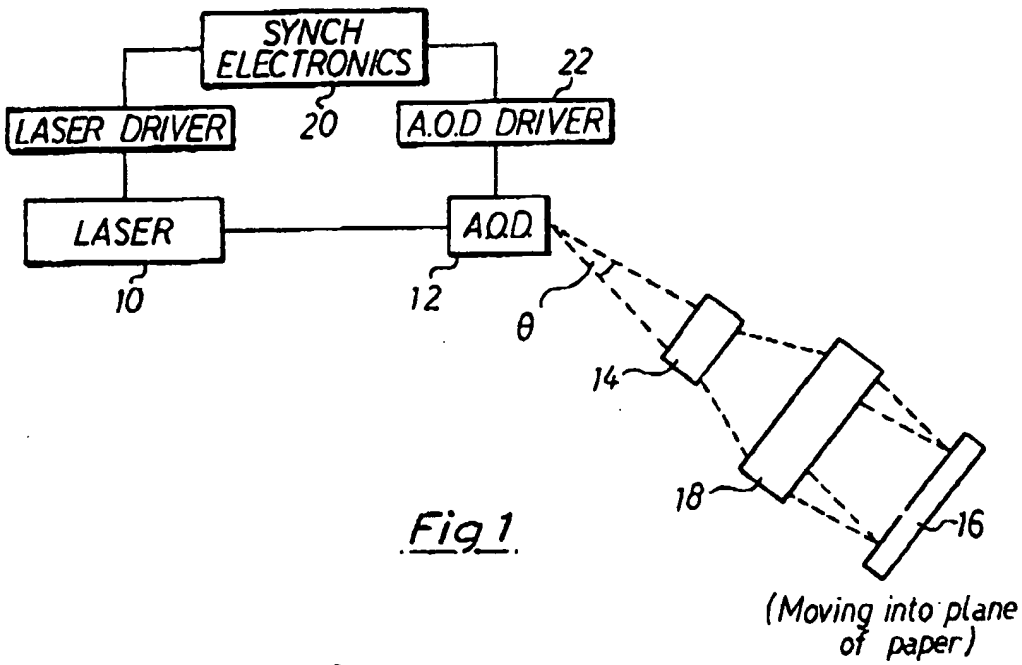

Fig 1.

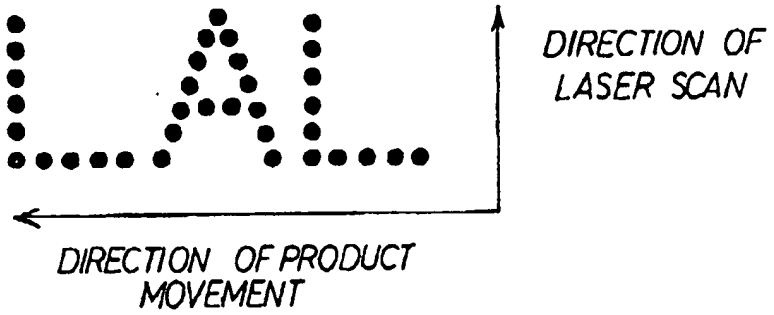

Fig 2.

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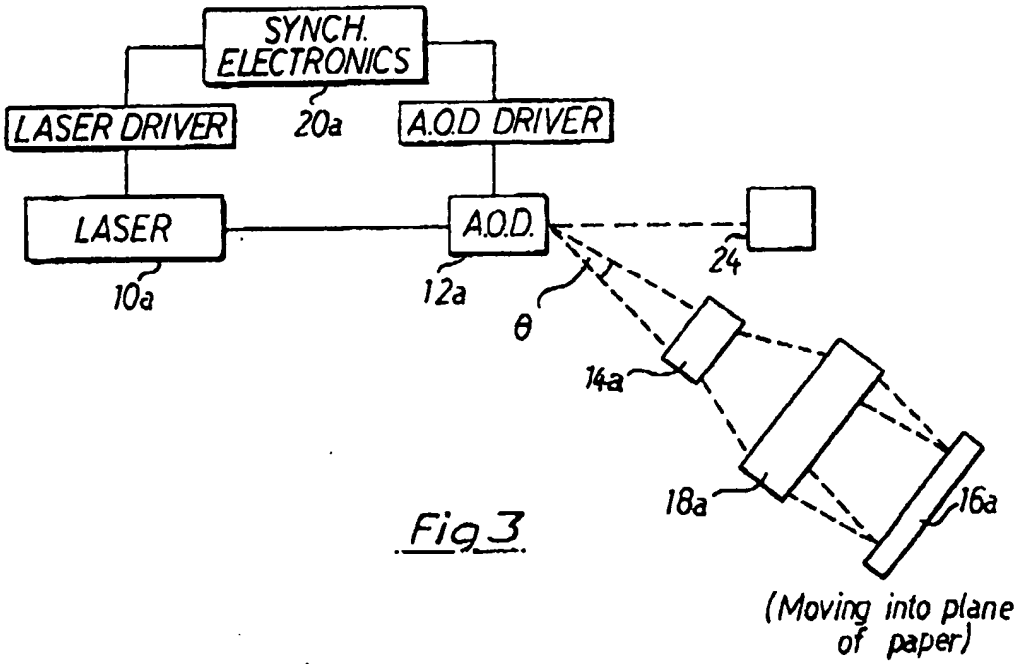

Fig 3

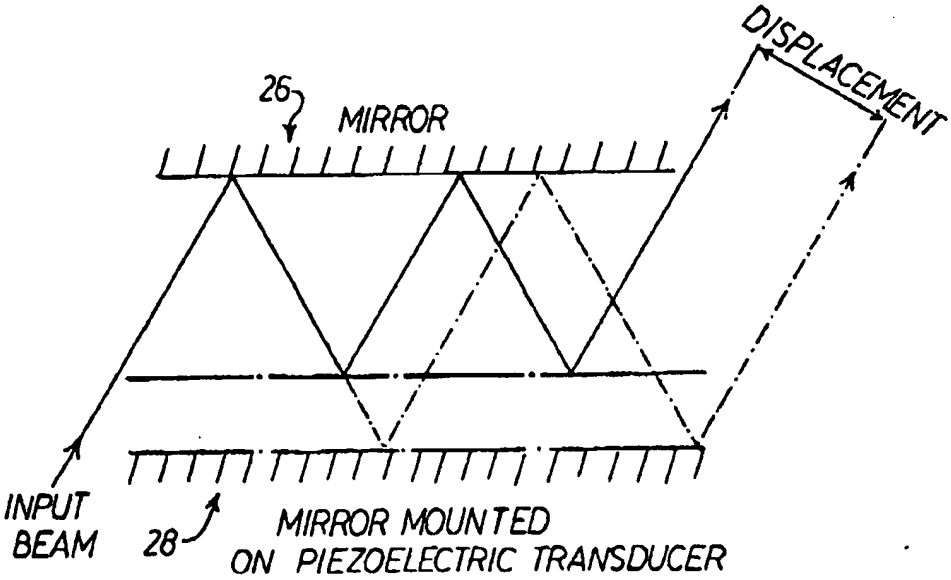

Fig 4

SPECIFICATION

A laser marking system

This invention relates to the marking of information on articles.

In a well-known technique for making information on articles, commonly used on conveying systems, a stream of ink is separated into fine droplets, which are then electrically charged and deflected by an electrostatic field onto the article to be marked. The combination of the article's movement on its conveyor and the orthogonal trajectory of the ink droplets, act to form a matrix of ink dots on the product, and this matrix can be conveniently changed in format, by suitably coding the electrostatic field, to produce the required information.

The present invention seeks to provide an alternative technique, whereby the ink droplets are replaced by pulses of laser light, thereby eliminating much of the messiness and inconvenience associated with ink-based systems.

In accordance with the present invention in its broadest aspect, an article is marked by means of a laser beam which is deflected and controlled such as to apply a plurality of laser burn dots in a predetermined pattern on the article to be marked.

In a preferred embodiment of the present invention, a CO_2 laser is amplitude modulated, and the pulse train so produced is deflected in space by means of an acousto-optic deflector. The one-dimensional array of pulses so produced may be magnified by means of a suitable optical system, and then focussed down on to the product to be marked, which is moving along a conveyor, by means of either a lens or a mirror, or a combination of optical elements. By suitable electronic control of the acousto-optic deflector, and in combination with the linear velocity of the article along its conveyor, a dot matrix of laser produced burns may be produced on the product, and this can be controlled in such a way as to produce the characters which are desired to be printed.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 shows diagrammatically a first embodiment of a marking system in accordance with the present invention;

Fig. 2 shows an example of product marking using the system of Fig. 1;

Fig. 3 shows diagrammatically a second embodiment of a marking system in accordance with the present invention; and

Fig. 4 shows a mirror arrangement for use in a further embodiment of the invention.

In the preferred embodiment of Fig. 1, a laser 10, which is an RF excited waveguide CO_2 laser delivering an output power in the region of 30 W, is amplitude modulated by direct modulation of the RF drive power. This provides a convenient means of obtaining a pulse train of frequency up to at least 100 kHz. This train of pulses is then focussed into an acousto-optic deflector (AOD) 12, where it is deflected into a range of angles θ, the deflection f a particular puls being determined by the drive frequency of the AOD 12 at the time that that pulse is in transit through the deflector. The RF drive to the laser and the AOD drive must thus be synchronised to each other.

The output from the AOD 12 is passed through a suitable optical system 14, where the angular field of the pulse train may be magnified, and is then focussed on to the product 16 by means of a focussing system 18. The particular spot size which is produced at the product will be a function of the laser output power, the scanning frequency and the surface material of the product, but might typically fall in the range 50 μm to 500 μm diameter. Thus, provided that the conveyor speed is synchronised with the laser modulation electronics 20 and the AOD driver 22, a dot matrix of characters is created as the product moves at right angles to the deflection line.

The pulses which are focussed on to the product by the focussing system 4, attain a minimum spot size which is dependent on the effective focal length of the focussing system. After reaching the minimum spot size, the beam diverges again, and thus the power density of a particular pulse is dependent upon the distance of the product from the focussing system. It will thus be appreciated that to ensure uniformity of marking (i.e. consistent spot sizes) the product 5 must always pass at the same distance from the focussing system 4, and to ensure that this is so, it is advisable to ensure that suitable guiding be arranged on the conveyor system (not shown).

It will also be appreciated that to print most characters, a continuous line of dots is only occasionally (see Fig. 2) required. Thus, the laser is arranged to be driven only at the particular instant that a dot is required, and the AOD also need only be driven at this time. This considerably increases the efficiency of the system, since it reduces the cooling requirements of both the laser and the AOD.

In a further embodiment of the present invention (not illustrated), instead of modulating an essentially continuous wave waveguide laser, a higher pressure pulsed laser, either RF excited or DC pulsed, may be employed. In this case, it is more difficult to achieve such high operating frequencies. However, since the peak power of a pulsed laser scales as the (gas pressure)^2, it is possible to achieve much higher peak powers with this technique, and thereby mark a wider range of product surfaces — subject, of course, to the AOD being able to handle the peak power without being optically damaged.

Another embodiment of the present invention, illustrated in Fig. 3, employs a continuous wave CO_2 laser 10a, either waveguide or non-waveguide, which is not modulated at all. When no drive to the AOD 12a is present, the continuous wave beam passes straight thr ugh and is blocked by a beam dump 24.

When a spot is required, the AOD 12a is driven by a pulse of suitable frequency, and the deflected

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When a spot is required, the AOD 12a is driven by a pulse of suitable frequency, and the deflected

beam passes through th rest of the system as before. Wh n the pulse ends, the beam returns to the beam stop (dump) position. Thus, by rapid stepwise changes of frequency, the same operation as described previously can be achieved. However, this system, although inherently simpler, suffers from the following disadvantages.

1. It requires a much more powerful cooling system, since the laser, AOD and beam dump must now be cooled.

2. It unnecessarily reduces the lifetime of the laser if it is a sealed off system.

3. It demands more exacting electronics, since the spots are being produced by stepwise changes of drive frequency.

4. It reduces the power handling capability of the overall system, and hence its marking capabilities, assuming the system is ultimately limited by the optical damage threshold of the AOD.

Another embodiment of the present invention utilizes a special coating to be applied to the surface of the article to be marked. This coating may, for instance, be a thermally sensitive compound, whose effect is to reduce the power density necessary to produce a visible mark. The sensitive surface may then be further treated after the application of the mark, to preserve the information.

In a further embodiment (not illustrated) the AOD 12 of Fig. 1 is replaced by a 2-dimensional (XY) acousto-optic deflector. This component permits a 2-dimensional array of spots to be generated, without utilising the movement of the product. Thus, even stationary products could be marked with this technique.

In yet another embodiment, the AOD is replaced by a mirror arrangement. This could, for example, be a multi-faceted spinning mirror, or an arrangement as shown in Fig. 4, where the laser beam reflects between two mirrors 26, 28, one (28) of which is mounted on a piezoelectric transducer. A displacement is created between the output beams which is dependent on the mirror displacement and the number of reflections occurring, and this displacement can be magnified as before with suitable following optics. One advantage of this system is that the mirror 28 which is mounted on the piezoelectric transducer can be moved quite rapidly, resulting in a fairly high marking speed.

CLAIMS

1. A method of marking an article wherein a laser beam is deflected and controlled such as to apply a plurality of laser burn dots in a predetermined pattern onto said article.

2. An apparatus for marking articles, comprising a laser and means for deflecting and controlling the laser output beam such as to apply a plurality of laser burn dots in a predetermined pattern onto an article t be marked.

3. An apparatus as claimed in claim 2 wherein the laser output beam is amplitude modulated and the pulse train so produced is deflected in space by means of an acousto-optic deflector.

4. An apparatus as claimed in claim 3 wherein the acoust -optic deflector is arranged to produce a one-dimensional array of laser pulses, which is magnified by an optical system and then focussed onto the article to be marked, the latter article being arranged to be displaced linearly in a direction perpendicular to said one dimensional array of pulses.

5. An apparatus for marking articles as claimed in claim 2, wherein the laser is a high pressure pulsed type, either RF excited or DC pulsed, the pulsed output beam of the laser being deflected in space by an acousto-optic deflector.

6. An apparatus for marking articles as claimed in claim 2, wherein the laser produces a continuous wave beam which is directed towards a beam dump by way of an acousto-optic deflector arranged such that when not driven it permits the beam to pass through to the dump but when driven by a suitably pulsed signal it deflects the laser beam in space to produce a one dimensional array of laser pulses, which is magnified by an optical system and then focussed onto an article to be marked, the latter article being arranged to be displaced linearly in a direction perpendicular to said one dimensional array of pulses.

7. An apparatus as claimed in claim 3, wherein the acousto-optic deflector is arranged to produce a two-dimensional array (X, Y) of laser pulses which is magnified by an optical system and then focussed onto the article to be marked, the article being stationary during the marking operation.

8. An apparatus as claimed in claim 2, wherein the laser beam is deflected by means of a mirror arrangement.

9. An apparatus as claimed in claim 8, wherein the mirror arrangement comprises a pair of parallel planar mirrors, one of which is mounted on a piezoelectric transducer, whereby the required displacement of the output pulses to the article to be marked is achieved by selective displacement of said one of the mirrors in dependence upon the energisation of the piezo-electric transducer.

10. An apparatus for marking articles, comprising a continuous wave laser whose output beam is directed onto an acousto-optic deflector, drive means for amplitude modulating the laser so that it directs a series of laser pulses to the acousto-optic deflector, electronic control means synchronised with the laser drive means for driving the acousto-optic deflector so as to selectively deflect the laser pulses in space to produce a one-dimensional array of pulses, an optical system for magnifying and then focussing the pulses in said array onto an article to be marked, which is arranged to be displaced linearly in a direction perpendicular to the one-dim nsional array of pulses, whereby by suitable electronic control of the acousto-optic deflector, nd in combination with the linear v locity of the article, a predetermined dot matrix of laser produced burns is produced on said article.

11. An apparatus for marking articles as claimed in claim 2, wherein the laser is an R.F. excited waveguide or non-waveguide CO_2 laser, amplitude modulated by direct modulation of the R.F. drive power.

12. An apparatus for marking articles, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

13. A method of marking an article substantially as hereinbefore described with reference to the accompanying drawings.

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